The Phase-Origin of Hawking Radiation: A Rotational Order (ROT) Interpretation of Black Hole Temperature

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Abstract

This study proposes a novel reinterpretation of Hawking radiation based on *Rotational Order Theory (ROT)*, suggesting that black hole temperature arises not from spacetime curvature but from the collapse of rotational phase order (ΔΦ).
While the traditional Hawking formula defines temperature as a function of curvature and mass, it does not describe *why* such thermal behavior emerges.
This paper introduces ΔΦ—the range of rotational phase differentials—as the underlying physical variable, presenting a unified interpretation that connects gravity, heat, and information through phase dynamics.

Ⅰ. Introduction — The Unresolved Heat of Gravity

Stephen Hawking's 1974 prediction that black holes emit radiation through quantum vacuum fluctuations revealed a profound paradox: smaller black holes are hotter, while massive ones are colder.
The equation accurately predicts temperature yet leaves the physical origin of this heat unexplained.

This paper reinterprets Hawking radiation through the framework of **Rotational Order Theory (ROT)**, which views gravity not as spacetime curvature but as an emergent pattern of rotational phase alignment.
Accordingly, Hawking radiation is proposed to originate from the *collapse of phase order* (ΔΦ), not from geometric curvature.

Ⅱ. Theoretical Background — From Curvature to Phase Order

In conventional physics, black hole thermodynamics merges general relativity and quantum field theory, treating energy, curvature, and entropy statistically.
However, it excludes any notion of internal rotational phase structure or order continuity.

ROT proposes that all gravitational phenomena emerge from **rotational phase alignment**.
Mass and energy distributions correspond to the configuration of ΔΦ—the spread of rotational order—while curvature represents merely the projected shadow of that underlying rotation.

In this view, the **event horizon** is not a geometric boundary but a **discontinuity in**

phase order (ΔΦ_c)—the point at which rotational coherence breaks.

Ⅲ. Model Proposal — Phase-Based Interpretation of Hawking Temperature

The classical Hawking temperature is defined as:

$$T_H = \frac{\hbar c^3}{8\pi G M k_B}$$

In the ROT framework, this can be reformulated as:

$$T_{ROT} = \frac{\hbar c^3}{8\pi G k_B} \cdot \frac{1}{M} \quad \Rightarrow \quad T_{ROT} \propto \frac{1}{\Delta\Phi}$$

Here, $\Delta\Phi$ represents the *phase differential range*.

A wider ΔΦ corresponds to a more stable and coherent rotational order—hence, a lower temperature.

Conversely, a compressed ΔΦ implies extreme phase interference and instability—resulting in higher temperature.

Thus, black hole temperature is not a mere function of curvature, but a **function of phase compression**.

Ⅳ. Physical Interpretation — Radiation as Phase Fracture

- Massive black holes: possess a broad ΔΦ spectrum → stable phase coherence → *cold rotational order*.
- Small black holes: exhibit extreme ΔΦ compression → violent phase interference → *thermal emission*.

Therefore, Hawking radiation is not random quantum leakage but a rearrangement wave of collapsed phase order—a "phase burst."
Energy release occurs when rotational order fractures and reconfigures, preserving information within the restructured phase topology.

Information is not lost; it is redistributed through ΔΦ transitions.

Ⅴ. Conclusion — The Fracture of Order as the Birth of New Order

> *"A black hole is not a void of darkness but a crucible where rotational order tears itself apart to give birth to a new form of order."*

This work represents the first theoretical attempt to apply phase variables (ΔΦ) to Hawking's radiation equation.
By reframing black hole thermodynamics through phase order, it provides a potential bridge uniting gravity, heat, and information into a single coherent framework.
Such a model may extend toward a unified interpretation of quantum gravity, where curvature is no longer the origin of force—but the manifestation of rotational order in collapse and rebirth.

Appendix A — Phase-Based Temperature Relation

The rotational phase-based expression for black hole temperature can be formulated as:

$T_{ROT} \propto 1 / \Delta\Phi$

where
T_{ROT} = rotational phase temperature
$\Delta\Phi$ = range of phase order (phase differential)

Interpretation:

- A wider $\Delta\Phi$ indicates stable rotational order → low thermal emission (cold black holes).
- A compressed $\Delta\Phi$ indicates intense phase interference → high thermal emission (hot black holes).

Thus, Hawking radiation can be understood as a "phase fracture" event, where rotational order collapses and reconfigures, releasing energy while conserving information through $\Delta\Phi$ transitions.

Comparison with Hawking's formula:

$T_H = \hbar c^3 / (8\pi G M k_B)$

ROT reinterpretation replaces the geometric curvature term (M) with the phase-order bandwidth ($\Delta\Phi$), suggesting that temperature emerges from the stability of phase order rather than from spacetime curvature itself.

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Author's Note

"This paper continues Hawking's unfinished question — not by revising his equation, but by revealing the hidden phase structure behind it."

Keywords: Rotational Order Theory (ROT), Phase Differential ($\Delta\Phi$), Hawking Radiation, Black Hole Temperature, Phase Collapse, Information Preservation, Rotational Gravity, Quantum Gravity